

Man's Power to Shape His Own Biologic Destiny – Will Society be Prepared to Use it Wisely?

By Marshall W. Nirenberg, National Heart Institute

New information is being obtained in the field of biochemical genetics at an extremely rapid rate which will undoubtedly continue to increase within the foreseeable future. Thus far, this knowledge has had relatively little effect upon man, basically, because more information must be obtained before practical application will be possible. The technical problems that must be overcome are formidable, to say the least. However, when these obstacles have been removed this knowledge will greatly influence man's future, for man then will have the power to shape his own biologic destiny. Such power can be used wisely or unwisely, for the betterment or detriment of mankind.

I think it is fair to say that most biochemical geneticists work because the search for knowledge is an exciting creative adventure—much as an artist's or poet's exploration is creative. His primary aim certainly is not that of creating powerful tools for society. However, the cumulative accretion of knowledge, bit by bit, does create such tools; thus the scientist has a responsibility which an eminent virologist, Salvadore Luria, has stated clearly and eloquently. Let me quote part of Luria's statement:

"The impact of science on human affairs imposes on its practitioners an inescapable responsibility. On the one hand, it creates the urge to seek useful applications and to foster their general acceptance. On the other hand, it may restrain the scientist from pursuing a line of research that is clearly leading to evil applications. Yet the progress of science is so rapid, almost catastrophic, that it creates an imbalance between the power it places in the hands of man and the social conditions in which this power is exerted. Then neither warnings of scientists, nor breadth of public information, nor wisdom of citizens may compensate for inadequacies of the institutional framework to cope with the new situations.

This paper was presented by Dr. Nirenberg, Chief, Laboratory of Biochemical Genetics, National Heart Institute, National Institutes of Health, at the Research Corporation Award Dinner in New York, January 19, 1967. Dr. Nirenberg received the foundation's 1966 Award for his pioneering experiments on protein synthesis which led to a partial "cracking" of the genetic code.

"The scientist should cultivate his own alertness to prospective scientific developments that may suddenly add new powers to man. The scientific habits of skepticism and restraint, of curbing fantasy, and distrusting fancy, inhibit the scientist's effort to speculate on what the future may bring. He must, however, within the limited means at his disposal, prepare the public to cope with the foreseeable consequences of advances he anticipates."

During the 1930s physicists realized that the release of nuclear energy was theoretically certain, but they doubted whether it would be of practical interest. Because of this uncertainty and the notion that scientists should mind their own business, physicists did little to inform society of what might come. When this power became reality society was unprepared, both intellectually and institutionally, to deal with it.

The public understands to some extent the recent developments in biochemical genetics, but has only a vague notion of what may be expected in the future, in spite of the efforts of many scientists to inform the public about probable future developments.

Where do we stand today? The genetic language now is known, and it seems clear that most, if not all, forms of life on this planet use the same language with minor variations. Simple genetic messages now can be synthesized chemically. Genetic surgery, applied to microorganisms, is a reality. Genes can be prepared from one strain of bacteria and inserted into another which is then changed genetically. Such changes are inheritable. Thus far, it has not been possible to program mammalian cells in this way.

What may be expected in the future? Short but meaningful genetic messages will be synthesized chemically. Since the instructions will be written in the language which cells understand, the messages will be used to program cells. Cells will carry out the instructions and the program may even be inherited. I don't know how long it will take before it will be possible to program cells with chemically synthesized messages. Certainly the experimental obstacles are formidable. However, I have little doubt that the obstacles eventually will be overcome. The only question is **WHEN?**

(Continued on page 4)

**Man's Power to Shape
His Own Biologic Destiny . . .**

(Continued from page 1)

If a poll were taken of a dozen knowledgeable investigators a dozen different answers probably would be obtained. My guess is that cells will be programmed with synthetic messages within twenty-five years. If effort along these lines were intensified, bacteria might be programmed within five years.

The point which deserves special emphasis is that man may be able to program his *own* cells with synthetic information long before he will be able to assess *adequately* the long-term consequences of such alterations, long before he will be able to ~~formulate~~ *formulate* goals, and long before he can resolve the ethical and moral problems which will be raised. When man becomes capable of instructing his own cells, he must refrain from doing so until he has sufficient wisdom to use this knowledge for the benefit of mankind. ~~The reason I state this problem well in advance of the need to do so,~~ is because the decisions concerning the application of this knowledge ultimately must be made by society, and only an informed society can make such decisions wisely.